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WaveNet: A Web-Based Metocean Data Access, Processing and Analysis Tool; Part 5 – WW3 Database

by Zeki Demirbilek, Lihwa Lin, Derek Wilson, and Jay Rosati

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes coupling of the WAVEWATCH III (WW3) database to WaveNet, the first module of MetOcnDat (Meteorological and Oceanographic Data or Metocean data) management and analysis system. This Part 5 technical note in the WaveNet series provides a step-by-step procedure for users to access, process, and analyze wave and wind data from the WW3 database.

BACKGROUND: U.S. Army Corps of Engineers (USACE) coastal modeling and planning missions require metocean data (e.g., winds, waves, tides, water levels). WaveNet is a web-based graphical-user-interface (GUI) data management tool that allows users to access, process, and analyze wave and wind data from different data sources. This GUI provides a combination of analysis and graphical tools to minimize the complexity and uncertainty in data processing for project needs. It allows users to check status of data processing, check the availability of data, and analyze quality and consistency of data. Users can extract, download, analyze, and prepare input files for numerical wave models and obtain tabular and graphical information for project planning and reporting and further analysis. Four previous companion CHETNs (Wilson et al. 2012; Demirbilek et al. 2013, 2014a, 2014b) provide descriptions and demonstrations of the WaveNet application to wave databases most frequently used in the United States. These earlier User's Guides describe details of the utility of WaveNet with the following databases: Part 1 for the National Data Buoy Center (NDBC); Part 2 for the Wave Information Study (WIS); Part 3 for the Coastal Data Information Program (CDIP); and Part 4 for the Great Lakes Observing System/Coastal Forecasting System (GLOS/GLCFS). Using step-by-step instructions, this Part 5 guide describes how to access the WW3 database using WaveNet. Incorporating an example application, it illustrates the processing and analysis of WW3 data for project planning, design, and evaluation studies, including how to generate input files for numerical wave models.

WaveNet employs a Google Map interface to query, select, and display data for a given geographic region from the different sources available. The user may select the date range to query the availability of data; plot, analyze, and extract data; postprocess to produce tabular data and plots in a desired format; and write input files for numerical models. WaveNet helps users to obtain statistical wave parameters such as significant wave height, peak period, and direction and generates wave and wind roses and histograms of directional wave data required to define the wave climate for Corps projects. Types of outputs available in WaveNet are image files (*.png), portable document files (*.pdf), Matlab figures (*.fig), text files (*.csv or *.txt), and spectral input files (*.eng) for numerical models. Users can modify the figures to view data plots as well as change axes and labels or text for project reports and other publications as necessary. The *.eng is an input file in the format required by numerical wave models CMS-WAVE and STWAVE (Demirbilek and Rosati 2011; Lin et al. 2011a, b; Massey et al. 2011; Lin et al. 2008).

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The WW3 is the latest, most advanced numerical modeling suite consisting of global and regional nested grids used by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) and National Centers for Environmental Prediction (NCEP). WW3 is used for nowcasting and forecasting to calculate waves, currents, and other atmospheric and weather parameters in the Atlantic and Pacific oceans, estuaries, and Great Lakes. The operational ocean wave predictions of NOAA/NWS/NCEP use WW3 with the operational NCEP products as input to provide estimates of conditions at the time the model was run to predict conditions into the future. The WW3 is run four times a day at 00Z, 06Z, 12Z, and 18Z. Each run starts with 9-, 6- and 3-hour (hr) hindcasts and produces forecasts of every 3 hr from the initial time out to 180 hr (84 hr for the Great Lakes). The model results provide five output variables, including significant wave height in meters, wave period in seconds, wave direction in degrees (deg), wind speed in meters (m)/sec and wind direction in deg, which are accessed and used by WaveNet. Additional background information, references, and validation data are available from the WW3 website (<http://polar.ncep.noaa.gov/waves>). The following example is designed to illustrate the use of WaveNet with the WW3 database. This is done in a step-by-step manner, with comments and instructions to guide users, where necessary.

EXAMPLE: WW3 Data for a Site in Hawaii

Assume wave and wind data for 2 months (1 June 2013 to 30 July 2013) are needed for a project in Pacific Ocean at the 20.20N latitude, 156.94W longitude. Project data needs include significant wave height, peak wave period, mean direction, wind speed, and wind direction in tabular form, as well as wave and wind roses and an *.eng file for CMS-Wave simulations. In this example, it is illustrated how to use WaveNet to access the WW3 database, fetch the data from the source, and prepare data in the required file formats for use in project documents and a numerical wave model.

Step 1: Start WaveNet. Click the following link on an ACE-IT computer to start the WaveNet server (<http://140.194.110.168:8000/GoogleMap3/default/Datamap>). Under the list of data sources at upper right, select **WW3**. Use the mouse and Google Map to move from the WaveNet main page to the Hawaiian Islands (Figure 1).

Step 2: Select the geographic point where data are needed. Zoom into the area of interest in Hawaii (Figure 1) and select the geographic location to access the point-specific data available from the WW3 database. In Figure 1, this could have been any point in the water body of Pacific Ocean. The user can select the radio button below **Click Point on Map to Define Data Station** located at the bottom of Figure 1 and then click to a water point in the ocean. The coordinates of the point will be displayed for the user to adjust, if necessary. WW3 data can be obtained from the 30-minute or 10-minute or 4-minute arc resolution grids. Next, the user can specify the start date (1 Jun 2013) and the end date (30 Jul 2013), choose metric or English for units, and then access the data source. There are two ways to access the data source: use WaveNet or go directly to the database's website. Step 3 describes these options.

Step 3: Access data source. Click **Retrieve/Plot Data** located at the bottom of Figure 1 to use WaveNet to fetch the wave height, period, and direction, as well as wind speed and direction time-series data from the data source for the user to view and process. Click on the **Access Wave Watch 3 Main Page** link located at the bottom of Figure 1 to directly access the WW3 website

(polar.ncep.noaa.gov/waves) shown in Figure 2. The user can explore types of data available and download and process data using preferred analysis programs, if so desired.

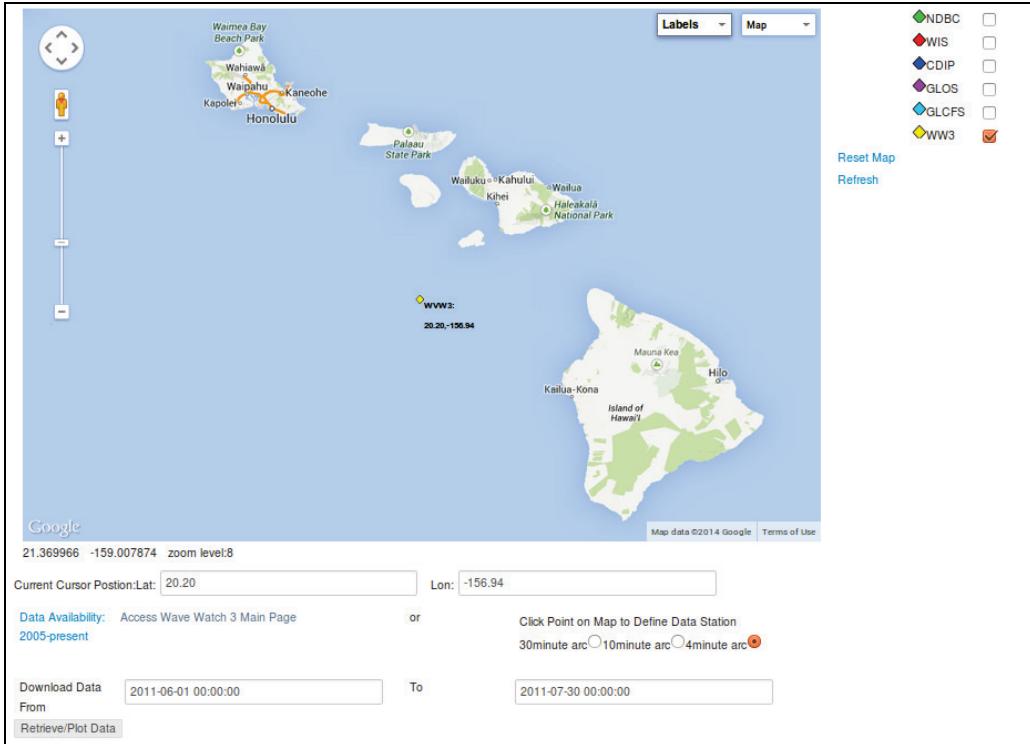


Figure 1. Zoomed-in Hawaii islands map within WaveNet user interface.

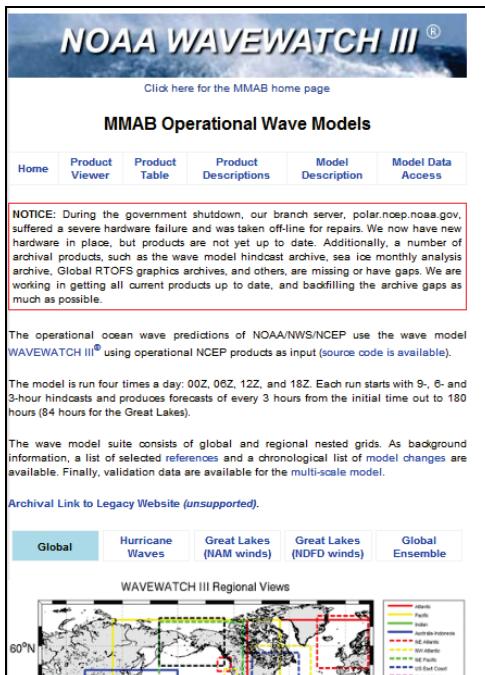


Figure 2. WW3 website main page.

Step 4: Data display and view. The *slider bar* shown at the bottom of Figure 3 can be used for changing the data display times. Use the calendar or the slider bar at the bottom of the plot or click on the display box to narrow the time window of interest to specific days or months. Double click within the start- and end-time boxes to get the calendar and either type in the **Start** and **End** date boxes or use the calendar to select dates (Figure 3). The timeline plot will show data availability for wave height and wind speed, including the data gaps, if any. To preview or download the selected station data, the user may plot wave data parameters either using the WW3 website data management tools or WaveNet's tools. In Figure 3, a time series of the wave height and wind speed is displayed for the user-specified time period. This display uses WaveNet, which provides a unified platform for the user to perform different tasks in a consistent manner to avoid potential errors and provides custom analyses not available from the data sources.

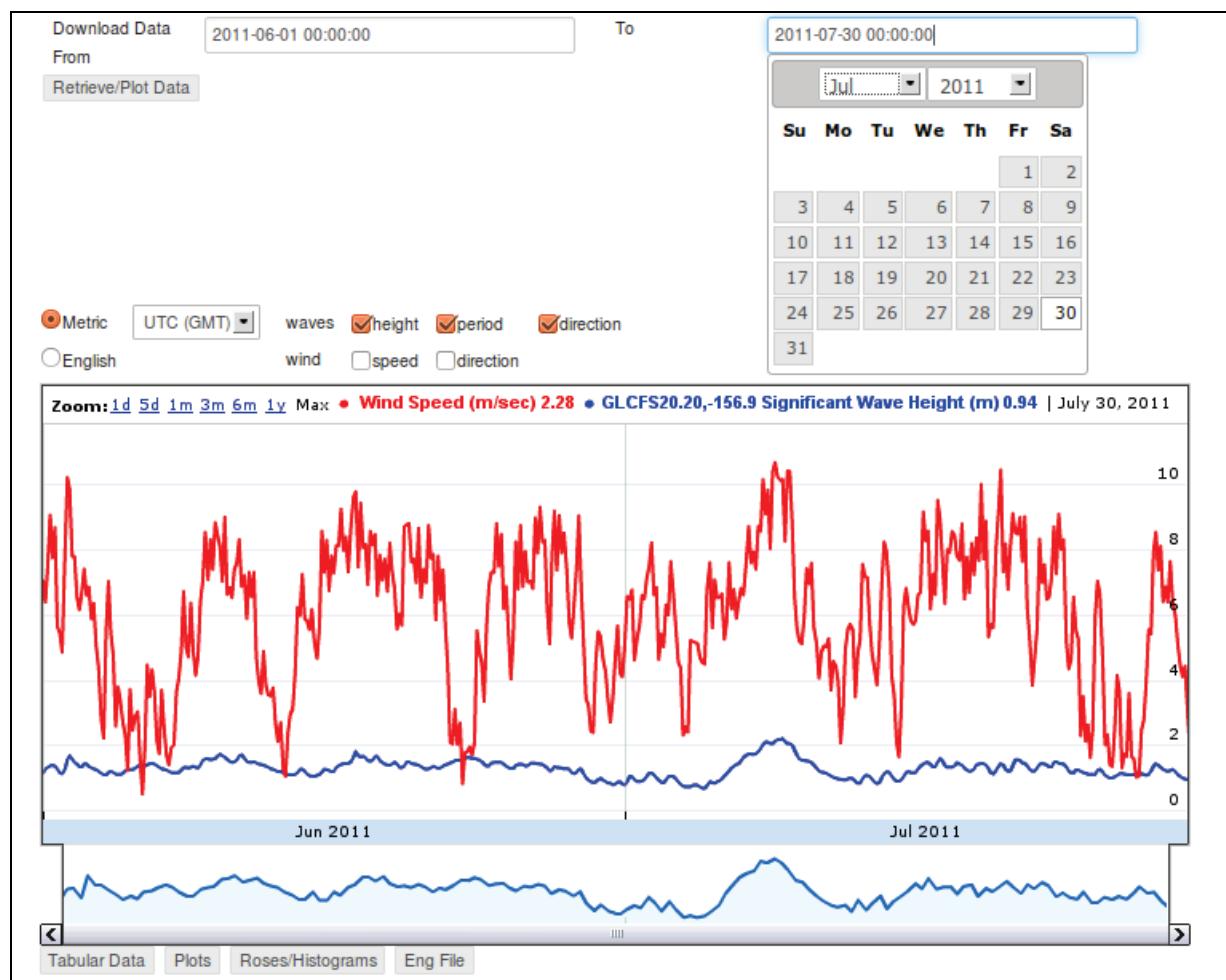


Figure 3. Time series of wave height and wind speed for user-selected time window.

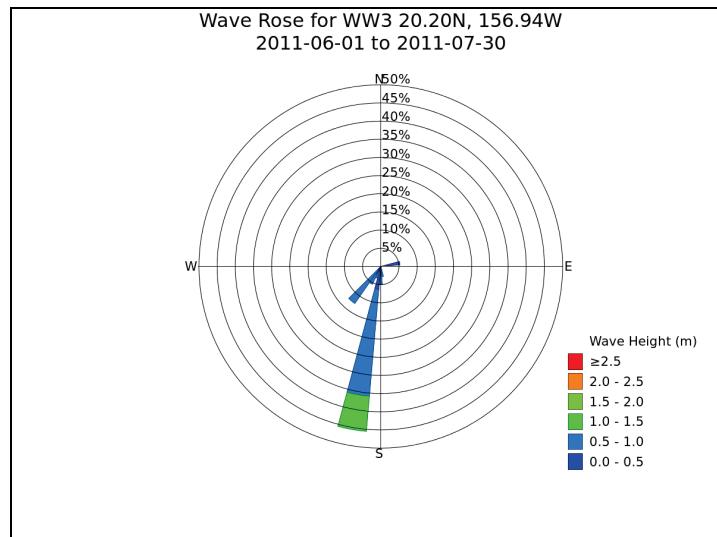
Step 5: Download data for project needs. Click on **Tabular Data** (Figure 3) to save data in a *.csv file. The “csv” is an ASCII spreadsheet with comma-separated values in text format. Table 1 displays a portion of a tabulated *.csv data saved by WaveNet. These ASCII data can also be used with the Matlab, Fortran, Excel, or other software or commercial plotting packages, and with numerical models, if desired.

Table 1. Tabulated data from *.csv file.

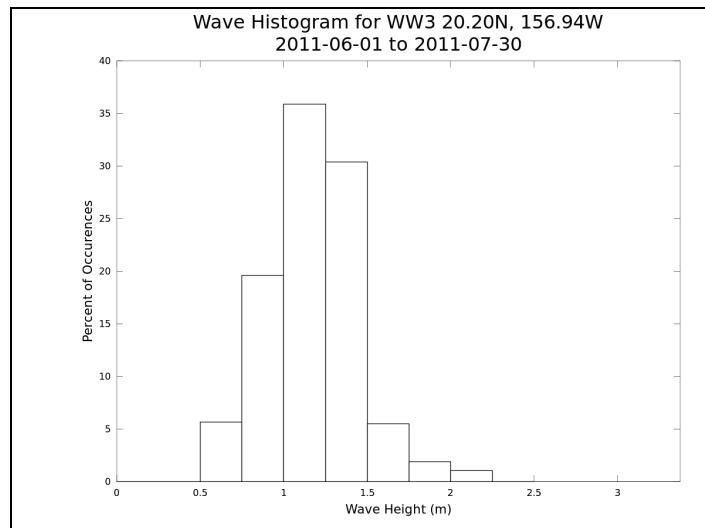
	A	B	C	D	E	F	G	H	I
1	yyyy	mm	dd	hh	WaveHt	WavePer	WaveDir	Wind Speed	Wind Dir
2					m	sec	deg	m/sec	deg
3	2011	6	1	0	1.15	8.8	94	7.1	203
4	2011	6	1	3	1.28	8.9	95	6.4	185
5	2011	6	1	6	1.34	8.8	95	7.5	208
6	2011	6	1	9	1.39	8.8	95	9.1	207
7	2011	6	1	12	1.4	8.8	95	7.8	212
8	2011	6	1	15	1.37	8.8	95	8.7	196
9	2011	6	1	18	1.29	8.8	94	5.7	185
10	2011	6	1	21	1.16	8.7	94	5.5	181
11	2011	6	2	0	1.13	8.6	84	4.9	197
12	2011	6	2	3	1.28	8.5	84	7.9	200
13	2011	6	2	6	1.57	8.4	84	10.2	199
14	2011	6	2	9	1.69	8.3	83	9.9	197
15	2011	6	2	12	1.6	8.3	82	7.8	205
16	2011	6	2	15	1.49	8.4	82	7.8	195
17	2011	6	2	18	1.43	8.4	81	6.6	195
18	2011	6	2	21	1.36	8.4	82	6.2	189
19	2011	6	3	0	1.35	8.5	82	6.7	187
20	2011	6	3	3	1.43	8.5	82	7.4	185

Step 6: Wave roses and histograms. If the data source does not provide rose plots or histograms, users can generate such plots using WaveNet's processing tools. Click on **Rose Plot/Histogram** below the timeline plot in Figure 3 to generate rose plots and histograms of waves and winds for the segment of data accessed or downloaded. In rose plots, the percent occurrence is depicted by radial circles, and the 0.5 m wave height bands are color coded in the radial direction in Figure 4(a). The direction bins for waves approaching the shore are displayed in color in Figure 4(a). Figure 4(b) shows the wave histogram that illustrates the statistical distribution of wave height.

The rose plot and histogram for wind speed are shown in Figure 5(a) and Figure 5(b), respectively. The 1 m/second wind speed bands are color coded in the radial direction (Figure 5(a)) with percent occurrence shown by radial circles. Statistical distribution of wind speed in Figure 5(b) shows the wind histogram. The colored direction bins of wind speed in Figure 5(a) represent the wind approach angles to the shore.



(a)



(b)

Figure 4. Rose plot and histogram of wave heights.

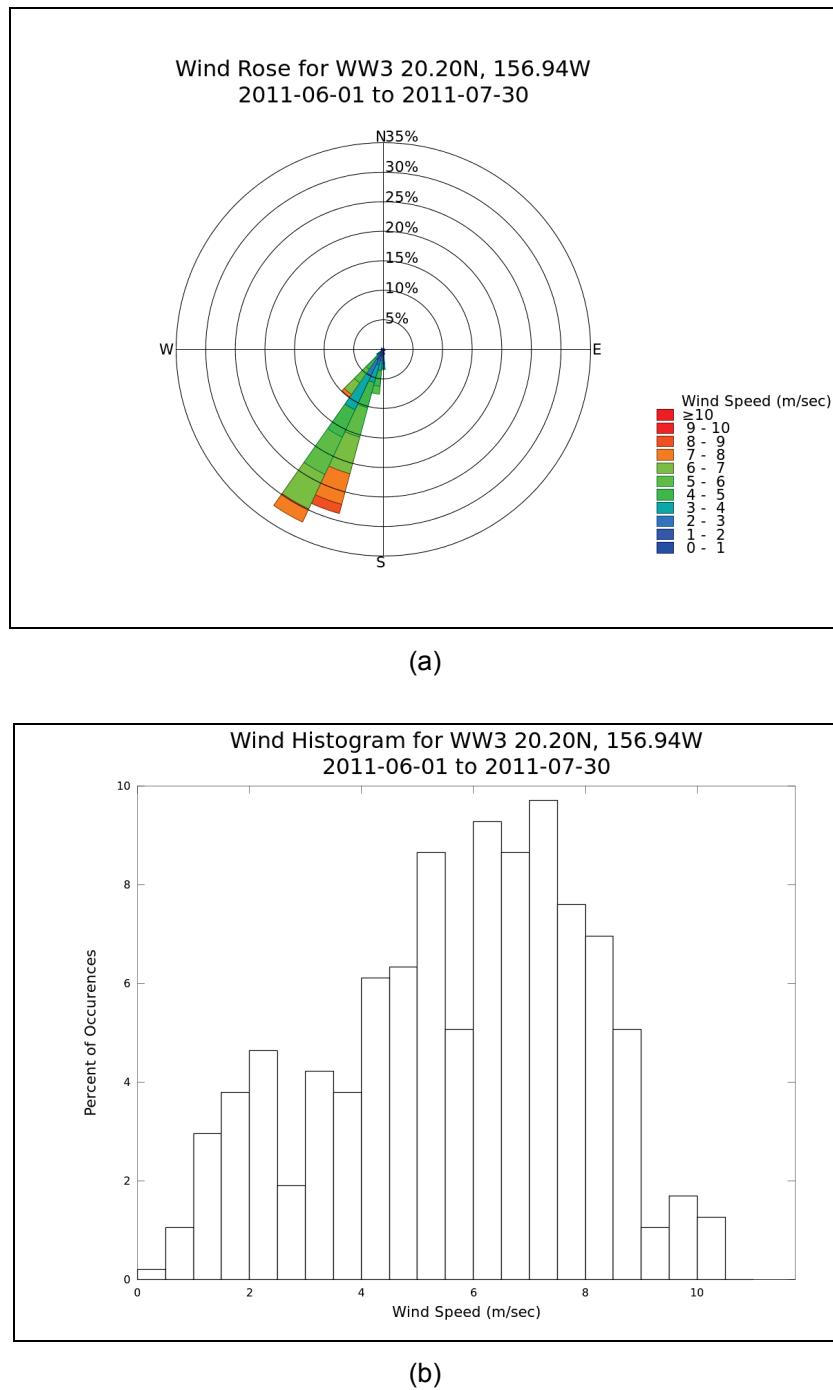


Figure 5. Rose plot and histogram of wind speed.

Step 7: Desktop data analyses. After accessing, reviewing, and downloading segments of data from the WW3 database to a local computer using WaveNet, users can perform some data analyses. For example, the CMS-Wave and STWAVE models require an *.eng file for directional wave input. If directional wave data (1D or 2D wave spectra and associated Fourier coefficients used to generate wave spectra) are available from the data source sites, users may download these to their computers to perform project-specific postprocessing analyses. If Fourier

coefficients are not provided by the data sources, the user may perform these operations using WaveNet. Click on the **Eng File** button located at the bottom of the timeline plot shown in Figure 6. Based on the timeline selected by the user, one or more *.eng file(s) will be generated and listed beneath the time series plot, as shown in Figure 6.

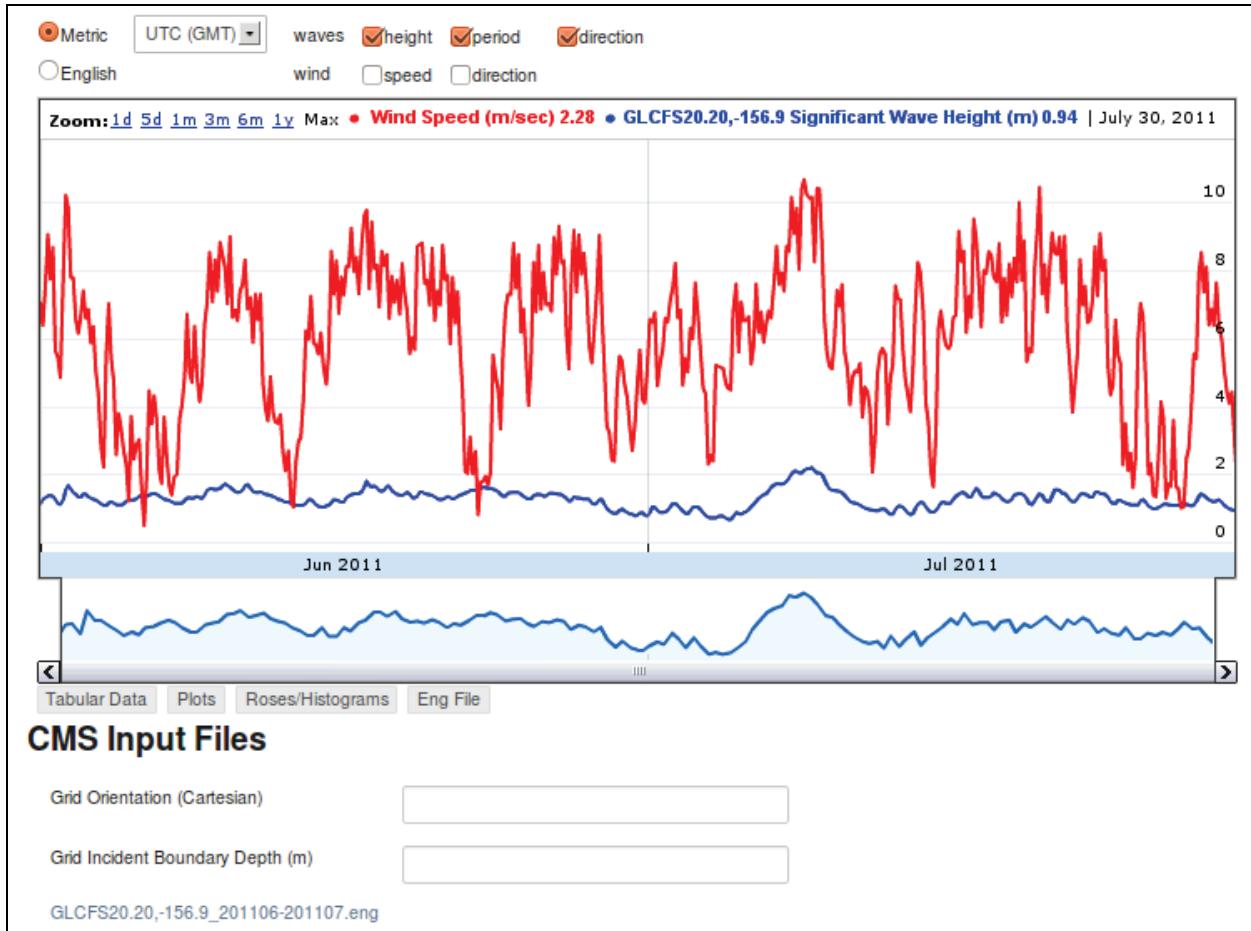


Figure 6. Link to an *.eng input file generated by WaveNet.

For illustration purposes, Table 2 displays a few top lines of a sample *.eng file. Lin et al. (2008, 2011a) provide additional information about the contents of *.eng files.

Table 2. Partial content of an *.eng wave input file generated by WaveNet.

30 35
0.04000 0.05000 0.06000 0.07000 0.08000 0.09000 0.10000 0.11000 0.12000 0.13000
0.14000 0.15000 0.16000 0.17000 0.18000 0.19000 0.20000 0.21000 0.22000 0.23000
0.24000 0.25000 0.26000 0.27000 0.28000 0.29000 0.30000 0.31000 0.32000 0.33000
9040821 9.1 -42. 0.30000 0.00
0.00032 0.00033 0.00034 0.00034 0.00034 0.00033 0.00032
0.00030 0.00029 0.00026 0.00024 0.00021 0.00018 0.00015
0.00013 0.00010 0.00007 0.00005 0.00003 0.00001 0.00000
0.00001 0.00005 0.00010 0.00017 0.00025 0.00033 0.00043
0.00052 0.00062 0.00071 0.00081 0.00089 0.00097 0.00103
0.00108 0.00112 0.00114 0.00115 0.00114 0.00112 0.00108
0.00103 0.00097 0.00089 0.00081 0.00071 0.00062 0.00052
0.00043 0.00033 0.00025 0.00017 0.00010 0.00005 0.00001
0.00005 0.00017 0.00034 0.00056 0.00082 0.00111 0.00142
0.00174 0.00206 0.00238 0.00268 0.00296 0.00322 0.00343
0.00360 0.00373 0.00381 0.00384 0.00381 0.00373 0.00360
0.00343 0.00322 0.00296 0.00268 0.00238 0.00206 0.00174
0.00142 0.00111 0.00082 0.00056 0.00034 0.00017 0.00005
0.00005 0.00017 0.00035 0.00057 0.00084 0.00113 0.00144
0.00177 0.00210 0.00242 0.00273 0.00302 0.00328 0.00350
0.00367 0.00380 0.00388 0.00391 0.00388 0.00380 0.00367
0.00350 0.00328 0.00302 0.00273 0.00242 0.00210 0.00177
0.00144 0.00113 0.00084 0.00057 0.00035 0.00017 0.00005
0.00009 0.00031 0.00063 0.00103 0.00151 0.00204 0.00261
0.00320 0.00380 0.00439 0.00495 0.00546 0.00593 0.00632
0.00664 0.00688 0.00702 0.00707 0.00702 0.00688 0.00664
0.00632 0.00593 0.00546 0.00495 0.00439 0.00380 0.00320
0.00261 0.00204 0.00151 0.00103 0.00063 0.00031 0.00009
0.00007 0.00025 0.00052 0.00086 0.00125 0.00169 0.00216
0.00265 0.00315 0.00363 0.00409 0.00452 0.00491 0.00524
0.00550 0.00570 0.00581 0.00585 0.00581 0.00570 0.00550
0.00524 0.00491 0.00452 0.00409 0.00363 0.00315 0.00265
0.00216 0.00169 0.00125 0.00086 0.00052 0.00025 0.00007
0.00007 0.00026 0.00053 0.00087 0.00127 0.00171 0.00219
0.00268 0.00318 0.00367 0.00414 0.00458 0.00497 0.00530
0.00557 0.00576 0.00588 0.00592 0.00588 0.00576 0.00557
0.00520 0.00497 0.00459 0.00414 0.00457 0.00419 0.00459

CONCLUSIONS: This Part 5 CHETN in the WaveNet series describes the coupling of WaveNet with the WW3 database in order to enhance the capabilities of WaveNet for Corps Districts. WaveNet has the ability to obtain project-specific data from the NOAA/NWS/NCEP nowcast and forecast predictions generated using WW3 modeling suite. An example is provided with a step-by-step procedure to illustrate how to use WaveNet to access wave data from the WW3 website and extract and analyze data for use in coastal navigation and storm damage reduction projects. This user's guide helps engineers and planners to obtain wave data for project planning, design, and evaluation study reports and develop input files for numerical wave models. As noted on the WW3 website, the modeling system used to develop WW3 data is evolving. Consequently, WW3 data in the future may also change in content, complexity, and accuracy of information. The goal is to enhance the capabilities of WaveNet to help Districts obtain data from the WW3 and other data sources which have been integrated with WaveNet. Therefore, user feedback is crucial and welcome from the USACE community for expanding and improving the capabilities of WaveNet for project applications. Also, users should be aware of the development of additional analysis capabilities for WaveNet to postprocess wave and wind data downloaded by users. Description and example applications of these analyses will be provided in the follow-up CHETNs in this series. Suggestions are welcome from District users about generic or customized frequency- and/or time-domain postprocessing analyses and capabilities for different project needs.

POINTS OF CONTACT: This CHETN was prepared as part of the Coastal Inlets Research Program (CIRP) and was written by a team. The POC for technical inquiries is Zeki Demirbilek (Zeki.Demirbilek@usace.army.mil). For information about CIRP, please contact the CIRP Program Manager, Julie Dean Rosati (Julie.D.Rosati@usace.army.mil). This technical note should be referenced as follows:

Demirbilek, Z., L. Lin, D. Wilson, and J. Rosati. 2015. *WaveNet: A web-based metocean data access, processing and analysis tool; part 5-WW3 database.* ERDC/CHL CHETN-IV-103. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

An electronic copy of this CHETN is available from <http://chl.erdc.usace.army.mil/chetn>.

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